

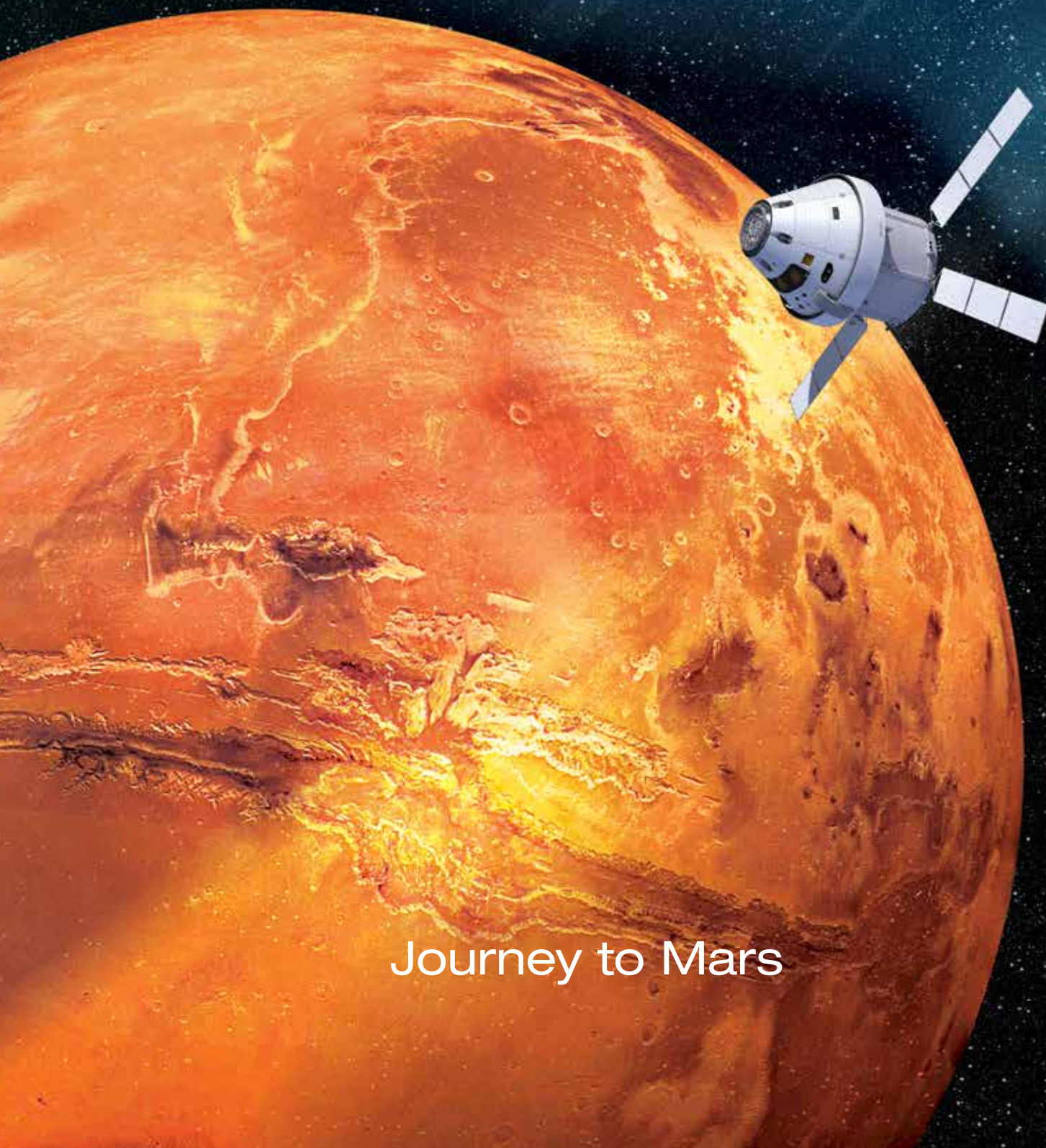
National Aeronautics and Space Administration



Roundup

LYNDON B. JOHNSON SPACE CENTER

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Journey to Mars

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On the cover:

Johnson Space Center programs and projects are an integral part of NASA's overall journey to Mars. Read more in this issue.

THE ONE-PAGE GRAPHIC on NASA's path to Mars shows Johnson Space Center all over the map, and I mean that in a good way. In fact, we produced the map—or, at least, we provided the initial version of telling the Mars story that NASA Headquarters refined into the version we are now using. Helping to tell the story is one of many contributions that JSC makes in exploration, and this issue of the *Roundup* describes a number of other contributions that are critical to enabling a human journey to Mars.

Referencing the graphic, in the **Earth Reliant** realm, our ongoing work on the International Space Station (ISS) is a key part of the exploration story. We're working to make access to ISS easier, quicker and more affordable for both NASA and external customers. We want station to be seen as a test facility—and not so different in preparation to using a ground test facility—but with results that are so much more relevant. We're changing perceptions, too. Space station can and should be part of a rapid prototyping, maximum use of commercial off-the-shelf hardware type of development environment, where failure is a normal part of reaching an end goal as long as crew and vehicle safety are preserved.

We're just a couple of months away from Orion's first flight test, our first flight foray into the **Proving Ground** part of the journey. Meanwhile, those supporting Orion are hard at work on the next mission, Exploration Mission (EM)-1, which will be the first flight with the Space Launch System rocket. Those two necessary components for missions beyond low-Earth orbit need to be supplemented by a variety of capabilities, the development of which is the focus of Advanced Exploration System projects, as well as other activities—some of which include the Engineering domain implementation plans. Demonstrating these capabilities is the purpose of proving ground missions.

JSC folks are also hard at work preparing for the Asteroid Redirect Mission (ARM) concept review in early 2015. This issue's coverage of NASA Extreme Environment Mission Operations illustrates our work in analogs that provide information on operational tools and concepts for ARM and similar missions.

While the EM series of missions move from left to right toward Mars, our architecture experts work from right to left, defining how a human mission to Mars might be carried out, and thus what it means to be **Mars Ready**. Our scientists are already helping to characterize the Martian environment, for which we need to plan. The journey to Mars is not just the focus of this issue; it is the focus of our new Exploration Integration and Science Directorate, JSC's own next step toward exploration.



NASA/PHOTO

Ellen Ochoa

Director, Johnson Space Center





By Melissa Gaskill

Space station research shows that hardy little space travelers could colonize Mars

IN THE MOVIES, humans often fear invaders *from* Mars. These days, scientists are more concerned about invaders *to* Mars, in the form of microorganisms from Earth. Three scientific papers examined the risks of interplanetary exchange of organisms using research from the International Space Station. All three—Survival of Rock-Colonizing Organisms After 1.5 Years in Outer Space, Resistance of Bacterial Endospores to Outer Space for Planetary Protection Purposes and Survival of *Bacillus Pumilus* Spores for a Prolonged Period of Time in Real Space Conditions—have appeared in the *Astrobiology Journal*.

Organisms hitching a ride on a spacecraft have the potential to contaminate other celestial bodies, making it difficult for scientists to determine whether a life form existed on another planet or was introduced there by explorers. Spacecraft landing on Mars or other planets where life might exist must meet requirements for a maximum allowable level of microbial life, or bioburden. These acceptable levels were based on studies of how various life forms survive exposure to the rigors associated with space travel.

“If you are able to reduce the numbers to acceptable levels, a proxy for cleanliness, the assumption is that the life forms will not survive under harsh

space conditions,” said Kasthuri J. Venkateswaran, a researcher with the Biotechnology and Planetary Protection Group at NASA’s Jet Propulsion Laboratory and a co-author on all three papers. However, recent research has shown that some microbes are hardier than expected, and others may use various protective mechanisms to survive interplanetary flights.

Spore-forming bacteria are of particular concern, because spores can withstand certain sterilization procedures and may best be able to survive the harsh environments of outer space or planetary surfaces. Spores of *Bacillus pumilus* SAFR-032 have shown especially high resistance to techniques used to clean spacecraft, such as ultraviolet (UV) radiation and peroxide treatment. When researchers exposed this hardy organism to a simulated Mars environment that kills standard spores in 30 seconds, it survived 30 minutes. For one of the recent experiments, *Bacillus pumilus* SAFR-032 spores were exposed for 18 months on the European Technology Exposure Facility (EuTEF), a test facility mounted outside the space station.

“After testing exposure to the simulated Mars environment, we wanted to see what would happen in real space, and EuTEF gave us the chance,” Venkateswaran said. “To our surprise, some of the spores survived for 18 months.”

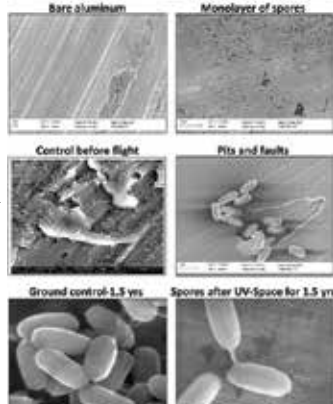
The findings also provide insight into how robust microbial communities are able to survive in extremely hostile regions on Earth and how these microbes are affected by radiation.

In another investigation, spores of *Bacillus pumilus* SAFR-032 and another spore-forming bacteria, *Bacillus subtilis* 168, were dried on pieces of spacecraft-quality aluminum and subjected for 1.5 years to the vacuum of space, cosmic and extraterrestrial solar radiation and temperature fluctuations on EuTEF. These samples also were subjected to a simulated Martian atmosphere using EuTEF. Most of the organisms exposed to solar UV radiation in space and in the Mars spectrum were killed, but when UV rays were filtered out and samples were kept in the dark, about 50 percent or more of those subjected to other space- and Mars-like conditions survived. That makes it likely that spores could endure a trip on a spacecraft to Mars if sheltered against solar radiation—perhaps in a tiny pocket of the spacecraft surface or underneath a layer of other spores.

The third study placed rock-colonizing cellular organisms in the EuTEF facility for 1.5 years, further testing a theory of how organisms might move from one planet to another, known as lithopanspermia. In this scenario, rocks ejected from a planet by impact with, say, a meteor, carried organisms on their surface through space and then landed on another planet, bringing that life with them. For this investigation, researchers selected organisms especially adapted to cope with the environmental extremes of their natural habitats on Earth, and found that some are also able to survive in the even more hostile environment of outer space.

Future exploration missions can use the results of these investigations to help find ways to minimize the risk of contaminating another planet. That’s a certainly good thing, because no one wants to be responsible for an “alien invasion” of Mars.

IMAGE CREDIT: P. VAISHAMPAYAN, ET AL. / ASTROBIOLOGY



Electron micrographs of *Bacillus pumilus* SAFR-032 spores on aluminum before and after exposure to space conditions.



The European Technology Exposure Facility attached to the Columbus module of the International Space Station during orbital flight.

IMAGE CREDIT: DLR, INSTITUTE OF AEROSPACE MEDICINE/DR. GERDA HORNECK

Operation **kick up red dust**—yes, there's a strategy for that



By Catherine Ragin Williams

WITH AN AVERAGE DISTANCE separating the celestial bodies of 140 million miles, Earth and Mars are far enough apart that the possibility of humanity reaching the Red Planet has been, so to say, *remote*. However, NASA Headquarters and its centers, Johnson Space Center included, have been working on a long-term strategy that makes kicking up red dust with our space-suited boots attainable—and not only something to be read about in a dog-eared science fiction novel.

It comes down to this: “How do we get to a point where we can send crews into space on a mission where they’re all by themselves and there is no quick return home?” said Deputy Manager of the Exploration Missions and Systems Office Bret Drake. “If something goes wrong, the crew has got to be able to respond to it . . . all on their own.”

The campaign to do just that is not a linear path—but several pathways and capabilities that NASA will evolve as exploration systems come online. The studies being conducted across the agency under the rubric of the **Evolvable Mars Campaign** are defining a flexible strategy that will incorporate all the major players to move us beyond Earth reliance.

JSC has a lot to contribute along this journey to Mars.

“Next year, we’re going to conduct the first one-year crew rotation (on space station),” said Kent Joosten, a consultant with the Exploration Missions and Systems Office. “That’s a big step, and it’s on the road to learning how we can commit people to live and work for years in space without the option to return home immediately. The International Space Station is the place to do that, and we’re lucky to have it.”

The two heavy hitters on the chessboard poised to make the next move into the cosmos are Orion and its corresponding heavy-lift rocket, the Space Launch System.

“Orion is going to be the workhorse for the next 10 to 15 years,” Joosten said. “It’s going to be taking crews into the proving ground of cis-lunar space, or into deep space, for longer and longer periods of time and bringing them back, so it’s going to be our ‘people mover’ for getting crews out to where we can learn to go to Mars.”

The Asteroid Redirect Mission is another major pathway in the quest for humans on Mars, which will demonstrate what can be achieved in

destinations like orbits around the moon, or that general area of deep space.

“If we do bring back a captured asteroid, how do the astronauts interact with it?” Joosten said. “How do we use the capabilities of Orion to do that? It’s really the whole mission-planning aspect of how we will use our vehicles, our people and our ground operations expertise to accomplish these things.”

Other pieces in the human spaceflight arsenal buoy the Evolvable Mars Campaign strategy and are necessary for continued progress. NASA’s Human Research Program, Advanced Exploration Systems, Office of the Chief Technologist, Space Technology Mission Directorate, Science Mission Directorate, and subgroups such

as robotics, structures, power and thermal systems complement missions that the agency will undertake to reach the Red Planet—the ultimate human destination.

Guiding Drake, Joosten and the multi-center teams hard at work to define this journey to Mars is Bill Gerstenmaier, associate administrator for Human Exploration and Operations at NASA Headquarters.

“We’re focused on developing the essential capabilities that will allow us to cut our dependence on Earth,” Gerstenmaier said. “The boldness and complexity of this endeavor calls to duty not only the brightest minds at NASA, but also the international and commercial partners who have been with us all along.”

Emerging architectures will also allow us access to Mars.

“The asteroid redirect vehicle, the solar-electric propulsion vehicle—it’s going to be a demonstration of a system to efficiently transport large masses in space,” Drake said. “We need to go beyond that, to develop an architecture that can optimally pre-position cargo in support of future human missions to Mars.”

“Right now, one of the major needs for human Mars exploration is advanced in-space propulsion,” Joosten said. “We’re trying to make the technology that is proposed for the Asteroid Redirect Mission scale up to what we need for human missions.”

Along with seriously “Star Trek” propulsion needs are radical options for life support. One mystery of how to do this could be solved with the Mars 2020 robotics mission.

“On the next rover mission to Mars planned for launch in 2020, a payload was selected that will actually demonstrate how we extract oxygen—breathable oxygen—from the atmosphere of Mars,” Joosten said.

What else could that oxygen contribute to? Rocket propellant for use in blasting off from the Martian surface.

“The Mars 2020 mission will help prove the technologies we will need to exploit in situ Martian resources so future missions to Mars won’t have to take everything with them—again, part of cutting our dependence on Earth,” Drake said.

Joosten enthused, “You’re making air on Mars. Once you can do that kind of thing, it starts to be real.”

We’ve proven we can get a (literal) ton to the surface of the Red Planet, but for a human mission, “we’ve got to get at least 20 times that, in a single piece, on the surface of Mars,” Drake said. “Fundamentally new capabilities are required—and JSC is in the midst of that.”



NASA / PHOTO

A 16mm fisheye lens was used to show a wide-angle view of the Vertical Assembly Center (VAC) at NASA's Michoud Assembly Facility in New Orleans at a ribbon-cutting ceremony Sept. 12. The VAC is the largest spacecraft welding tool in the world, and part of a family of state-of-the-art tools designed to weld the core stage of the Space Launch System, the most powerful rocket ever built for missions deep in space.



NASA / PHOTO

The Asteroid Redirect Mission is a key pathway in the Evolvable Mars Campaign. Here, in this concept image, an astronaut stores a sample that was collected from a captured asteroid.

Johnson Space Center experts join **Mars** 2020 **mission**



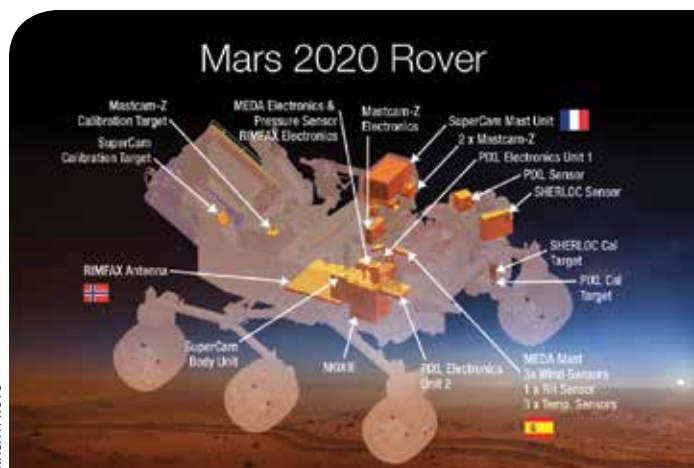
By Mark Carreau

Three scientists and engineers from Johnson Space Center will collaborate on NASA's Mars 2020 rover mission, providing far-reaching expertise to prepare for future human exploration of the Red Planet by seeking evidence of organic compounds, including those linked to possible ancient life, and subjecting samples of spacesuit materials to the planet's environment.

Curation Scientist Marc Fries and Organic Geochemist Aaron Burton from JSC's Astromaterials Research and Exploration Science Office, and Amy Ross from the Engineering Directorate's Crew and Thermal Systems Division, will support the rover's Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals (SHERLOC) instrument.

An advanced, fine-scale ultraviolet (UV) spectrometer, SHERLOC is one of seven instruments selected for the future rover by NASA's Mars Exploration Program in late July. The announcement followed an intense 10-month competition that drew proposals from 58 global instrument teams.

"It's a bend in the knee," Ross said. "We've been doing robotic missions to gather information about the planet and the environment. This is a small step that says humans really are going."



NASA PHOTO

An artist concept image of where seven carefully selected instruments will be located on NASA's Mars 2020 rover. The instruments will conduct unprecedented science and exploration technology investigations on the Red Planet as never before.

Mars 2020 will be the first mission to look directly for signs of ancient Martian life locked in telltale organics laced in the rock and soil. SHERLOC plays a crucial role in identifying surface samples that can be gathered and stored aboard the rover for return to Earth by a future mission.

Fries and Burton are among 15 co-investigators on the SHERLOC team. Ross, on a fortuitous summer rotation in Astromaterials, was recruited by the two scientists to contribute.

Past efforts by NASA missions to identify organic material on Mars dating back to the Viking 1 and 2 landers of the mid-1970s were likely derailed by the release of perchlorates, an oxidizer chemically locked in the regolith and identified by the Phoenix lander in 2008. If present, organics were likely destroyed as past landers collected, then heated samples of the regolith for analysis, explained Fries and Burton.

SHERLOC, which will be mounted up front on the 2020 rover, was developed with UV-detection technologies that can identify organics without heating, or even touching, the Martian regolith. The spectrometer is sensitive

enough to single out individual microbial cells.

NASA's Mars Science Laboratory and Opportunity mission rovers, now in their third and 11th years on the Martian surface, have gathered evidence the planet once hosted environmental conditions favorable for biological activity. If life emerged, planners would like to know before humans visit.

Human discovery could leave open the question: Was there life on Mars before they arrived, or did humans bring it?

The issue is further complicated by the possibility that life arose independently on Mars and Earth, and then transferred between the planets, possibly multiple times, in fragments dislodged and blasted into space by meteorite and comet impacts.

Ross will develop a calibration target to ensure that SHERLOC's vision is as sharp on Mars as it is on the Earth using polymeric materials conveniently found in NASA spacesuit materials.

"It's a very nice convergence of needs," Burton said.

Over time, SHERLOC will reveal how well spacesuit fabrics worn by astronauts for three decades withstand exposure from the sun's UV radiation and other destructive elements in the Martian environment.

"This is a big deal," Ross said. "Change makes our job more difficult. We have to get used to the character of new materials—how it sews, works under pressure and stands up over time."

The small target will hold several postage-stamp-sized samples of Ortho-fabric, which form the outermost layer on suits worn by shuttle and International Space Station astronauts; the polycarbonate visor material from the helmet; contact surface polymer and Teflon fabric from the palm and gauntlet of the glove; and Spectra webbing and polyester that serve a crucial restraint function.

The target may carry another intriguing calibration target—a small piece of a Martian meteorite, possibly Nakhilite 090032, discovered in Antarctica's Miller Range and currently among the astromaterials archived at JSC.

"It's a piece of Mars we have studied with our instrument," Fries said, who was part of the 2009-2010 Antarctic Search for Meteorites team that made the rare find. "As far as we know, it will be the first rock to complete a roundtrip between the planets."

Mars 2020 is scheduled for launch in July or August of 2020. The rover would reach its destination between January and March of 2021 to start a primary mission lasting one Martian year, or 687 Earth days.



NASA/JPL-CALTECH/MALIN SPACE SCIENCE SYSTEMS

This image shows the target currently on the Curiosity rover, but it is similar to what the calibration target will look like for the Mars 2020 mission.

Next stop: Deep space



By Brandi Dean

IN DECEMBER, ORION will launch into space for a 4.5-hour flight that will take it 3,600 miles above Earth—farther than any spacecraft built for humans has gone in more than 40 years. But that's barely scratching the surface of Orion's capability.

For this first flight, Exploration Flight Test-1, Orion's launching aboard a Delta IV Heavy rocket. It's the largest rocket currently available, but even with all that power, it can't boost Orion out of low-Earth orbit. For that we'll need something bigger.

To blast Orion out of low-Earth orbit, NASA is building the Space Launch System (SLS), the only rocket currently in development powerful enough to send humans into deep space. Once it's ready, Orion will waste no time getting there. On Exploration Mission-1 (EM-1)—Orion's second mission and SLS's first—the 70-ton evolvable rocket will send an uncrewed Orion on a 25-day mission into lunar distant retrograde orbit, a large orbit around the moon that beyond what any human spaceflight system has ever traveled.

"Orion's being built to take us farther than humans have ever gone before," said Orion Program Manager Mark Geyer, "and we plan to do that right out of the gate, with EM-1."

Orion and SLS have both already started work on the spacecraft and rocket that will be making that trip. The SLS team has completed the critical design review on the rocket's core stage and boosters, and welding

is done on 10 barrels for the core stage and all the rings that connect and provide stiffness between the domes and barrels that make up the five major core stage structures. Meanwhile, even as the first Orion spacecraft is being completed, many members of the Orion team have moved on to work on the second. Key elements of the primary structure pathfinder unit have already been manufactured and delivered to the subcontractors working on those elements so that they could begin machining them.

"The data from the first flight will be welcome, and we'll use it," said Charlie Lundquist, Orion's crew and service module manager. "But we're not waiting—we're pressing ahead. We have a lot of lessons learned just from building the first vehicle that we can start using right now."

EM-1 will be our last chance to test the vehicle before people are on board. Orion's first crew is scheduled to launch on Exploration Mission-2, which will likely take two astronauts into a high lunar orbit.

Following Exploration Mission-2, the first major destination for Orion is set to be an asteroid that will be brought into orbit around the moon by a robotic spacecraft. Called the Asteroid Redirect Mission, or ARM, it will make it possible for astronauts to explore an asteroid for the first time while providing the necessary experience and advancing new technologies needed to send humans to Mars.

"We're definitely on a path to Mars, and we are closer than we have ever been with Orion and SLS in development—but we've got a lot to learn first,"



NASA/PHOTO



Astronauts Rick Linnehan and Mike Foreman try out a prototype display and control system inside an Orion spacecraft mock-up at Johnson Space Center during the first ascent and abort simulations for the program.

said Steve Stich, head of Johnson Space Center's new Exploration Integration and Science Directorate. "These initial Orion missions are certainly part of that learning process—they're part of our journey to Mars."

The deep-space environment around the moon is different than low-Earth orbit, but very similar to what astronauts would experience on the trip to and from Mars. For instance, solar and cosmic radiation are more prevalent, and transit times to and from Earth are greater. This makes cis-lunar space ideal to test capabilities needed for longer-duration missions to Mars or its moons, where there are fewer ties with Earth.

With that experience under our belts, along with the additional knowledge already being accumulated by the robotic missions to the Red Planet, NASA plans to send the first crew of astronauts to Mars in the 2030s. There, they'll hopefully help us answer questions about microbial life in Mars' past, its potential as a home for humans in the future and what it can tell us about how our planet was formed.

NASA/PHOTO



In this concept image, the Orion spacecraft docks with the robotic asteroid redirect vehicle.

Orion

moves closer to launch

ORION'S FIRST FLIGHT TEST is almost here, and the vehicle itself is nearly ready.

Engineers finished building the Orion crew module in September, and attached it and the already completed service module to the adapter that will join Orion to its rocket before transporting the spacecraft to Kennedy Space Center's Payload Hazardous Servicing Facility for fueling.

"Nothing about building the first of a brand new space transportation system is easy," said Mark Geyer, Orion Program manager. "But the crew module is undoubtedly the most complex component that will fly in December. The pressure vessel, the heat shield, parachute system, avionics—piecing all of that together into a working



NASA/RAD SIWYAK

NASA's first completed Orion crew module sits atop its service module at the Neil Armstrong Operations and Checkout Facility at Kennedy Space Center in Florida.

spacecraft is an accomplishment. Seeing it fly in December is going to be amazing."

Finishing the Orion crew module marks the completion of all major components of the spacecraft. The other two major elements—the inert service module and the launch abort system—were completed in January and December, respectively. The crew module was attached to the service module in June to allow for testing before the finishing touches were put on the crew module.

Inside the Payload Hazardous Servicing Facility, Orion's reaction control system is being fueled with ammonia and hydrazine for the December flight. Next, the crew and service module stack will move to the Launch Abort System Facility for the installation of the final element. Once the launch abort system has been added to the stack, the vehicle will be complete and ready to roll to the launch pad in November for integration on the Delta IV heavy rocket that will send it into space.

NEEMO 19 aquanauts complete underwater mission



By Bill Jeffs

FOUR AQUANAUTS SPLASHED up from the depths of the Atlantic Ocean on Sept. 14, bringing to a successful close the weeklong 19th NASA Extreme Environment Mission Operations (NEEMO) expedition.

The NEEMO 19 crew spent seven days living and conducting research 62 feet below the surface in Florida International University's Aquarius Reef Base undersea research habitat off the coast of Key Largo, Florida. NASA astronaut Randy Bresnik commanded the mission. He was joined by Canadian Space Agency astronaut Jeremy Hansen, European Space Agency (ESA) astronaut Andreas Mogensen, and Herve Stevenin, ESA's Head of Extravehicular Activity (EVA) Training at the European Astronaut Center in Cologne, Germany. The crew was accompanied by two lab technicians.

"This past week of living aboard Aquarius as saturated divers has been filled with awe and wonder," Bresnik said. "The majesty of this beautiful undersea world was a beauty to behold. The dangers are self-evident and ever present, but so were the amazing opportunities to train in such a unique and hostile environment. Overcoming these challenges made the results of our work seem all that more rewarding. Evaluating equipment, developing procedures and researching operations in an environment with a delay in communications was our mission. Thanks to the hard work and dedication of the entire team of NEEMO 19, we were wildly successful."

The crew members of NEEMO 19 tested technologies and training techniques for use aboard the International Space Station and future deep-space exploration missions. Mission objectives included evaluating technologies to improve crew performance when executing standard space station procedures; testing tools and techniques to conduct spacewalk tasks across gravity levels ranging from asteroids to the moons of Mars and the Martian surface; and investigating the capability of just-in-time training for space station and future exploration missions.

Students from Embry Riddle Aeronautical University conducted robotics

and engineering investigations focused on technologies to support future space exploration missions and underwater operations.

NEEMO 19 EVA activities evaluated tools and techniques for exploration tasks across different simulated gravity fields. Techniques to address re-

planning of exploration operations to account for varying time delays in communications were also addressed, and the mission's scientific and exploration objectives completed.

Despite their busy schedules, crew members had time to reflect on life under the sea.

"Our schedule keeps us busy, but there are still times when you step back and realize where you are and what you're doing," Hansen said. "Last night as I fell asleep was one of those moments for me. In that quiet moment I realized I was lying in a relatively small metal can on the ocean floor with five other humans while a symphony of marine activity was underway around us. During those quiet times in the habitat, you hear so many weird and wonderful noises from the reef that both surrounds and covers the Aquarius habitat. Even the coral itself makes noise on the hull of the habitat."

For the crew members, the experience of living beneath the waves is something they will not soon forget. In Stevenin's words, "We watch an alien-like world full of life—from huge barracudas monitoring us to tiny little planktons dancing in front of our window at night. But this environment is their living universe, and we are the aliens visiting their world and 'coming in peace.'"

NEEMO 19 was the second undersea mission conducted this summer. In July the NEEMO 18 crew completed a nine-day mission that focused on a suite of studies

from NASA's Human Research Program, covering behavioral health and performance, human health and countermeasures, and human factors and habitability.

Akihiko Hoshide of the Japan Aerospace Exploration Agency commanded the mission. NASA's Jeanette Epps and Mark Vande Hei and Thomas Pesquet from ESA rounded out the crew.



NASA/PHOTO

NASA astronaut Randy Bresnik, pictured, commanded the NEEMO 19 underwater mission.

The world's most powerful rocket completes a key review

NASA RECENTLY ANNOUNCED the completion of a rigorous review of the Space Launch System (SLS)—the heavy-lift, exploration-class rocket under development to take humans beyond Earth orbit and to Mars—and approved the program's progression from formulation to development, something no other exploration-class vehicle has achieved since the agency built the space shuttle.

NASA/MARSHALL SPACE FLIGHT CENTER



Artist concept of NASA's Space Launch System (SLS) 70-metric-ton configuration launching to space. SLS will be the most powerful rocket ever built for deep-space missions, including to an asteroid and ultimately to Mars.

"We are on a journey of scientific and human exploration that leads to Mars," said NASA Administrator Charles Bolden. "And we're firmly committed to building the launch vehicle and other supporting systems that will take us on that journey."

For its first flight test, SLS will be configured for a 70-metric-ton (77-ton) lift capacity and carry an uncrewed Orion spacecraft beyond low-Earth orbit. In its most powerful configuration, SLS will provide an unprecedented lift capability of 130 metric tons (143 tons), which will enable missions even farther into our solar system, including such destinations as an asteroid and Mars.

This decision comes after a thorough review known as Key Decision Point C (KDP-C), which provides a development cost baseline for the 70-metric ton version of the SLS of \$7.021 billion from February 2014 through the first launch and a launch readiness schedule based on an initial SLS flight no later than November 2018.

Conservative cost and schedule commitments outlined in the KDP-C align the SLS program with program management best practices that account for potential technical risks and budgetary uncertainty beyond the program's control.

"Our nation is embarked on an ambitious space exploration program, and we owe it to the American taxpayers to get it right," said NASA Associate Administrator Robert Lightfoot, who oversaw the review process. "After rigorous review, we're committing today to a funding level and readiness date that will keep us on track to sending humans to Mars in the 2030s—and we're going to stand behind that commitment."

"The Space Launch System Program has done exemplary work during

the past three years to get us to this point," said Bill Gerstenmaier, associate administrator for Human Exploration and Operations at NASA Headquarters in Washington. "We will keep the teams working toward a more ambitious readiness date, but will be ready no later than November 2018."

In April, the program delivered the first piece of flight hardware for Orion's maiden flight, Exploration Flight Test-1, which is targeted for December. This stage adapter is of the same design that will be used on SLS's first flight, Exploration Mission-1.

SLS will be the most capable rocket the world has ever seen. In addition to opening new frontiers for explorers traveling aboard the Orion capsule, the SLS may also offer benefits for science missions that require its use and can't be flown on commercial rockets.

The next phase of development for SLS is the Critical Design Review, a programmatic gate that reaffirms the agency's confidence in the program planning and technical risk posture.

For more information about SLS, visit: <http://www.nasa.gov/sls>



NASA/MARSHALL SPACE FLIGHT CENTER

This artist concept shows NASA's Space Launch System, or SLS, rolling to a launchpad at Kennedy Space Center at night. SLS's flexible, evolvable design will meet a variety of crew and cargo mission needs.



Spotlight: Shanna DeLeon

Orion flight controller

Q: Coolest part of your job at Johnson Space Center?

A: Real-time spaceflight operations. There is no better feeling than being in the Mission Control Center (MCC) surrounded by highly competent engineers—knowing you are part of a flight control team who, together, are responsible for the success of a mission.

Q: What is your role in Orion's upcoming flight test?

A: I'm the lead INCO (Integrated Communications Officer) for the upcoming Orion test flight, Exploration Flight Test-1 (EFT-1). During the development phase of EFT-1, our team contributed operations expertise to system- and vehicle-level design trades. We later supported vehicle testing, ensuring the integrated vehicle acted as expected and fully vetted all commands and telemetry. Now we are focused on preparing for the upcoming launch, which we will operate from the Blue Flight Control Room in MCC. We are conducting facility testing, authoring/editing all operations products, refining the concept of operations and conducting and receiving training. During EFT-1, the INCO team, INCO and INCO support are responsible for sending all commands to the vehicle and managing the health of the communications and video systems.

Q: What would people be surprised to know about you?

A: Throughout high school I was an avid soccer player fortunate enough to be on a Texas 5A championship team, and was accepted as a member of the women's junior Olympic development team.

Q: If you could trade places with any other person for a week, famous or not famous, living or dead, real or fictional, who would it be?

A: My grandmother or grandfather during the World War II timeframe. My grandmother worked in an ammunitions factory in California, and my grandfather co-piloted B-24 heavy bombers, completing 36 missions over Europe before being wounded. Their generation endured so much at a young age; it's hard to imagine what they truly went through. I would love to be a fly on the wall and observe firsthand some of the tremendous stories they shared.

Q: What is your favorite indulgence?

A: Audio books. I have quite the commute, and audio books help to shorten the drive time.

Q: What do you wish you could tell your younger self?

A: Listen to your parents. Against everything I wanted to believe, they usually were correct.

Q: What seemingly "little things" bring you joy?

A: Sunsets with my husband and family at the lake house. It's hard to feel more relaxed and safe than in those moments.

Q: If you could vacation anywhere in the cosmos, where would you go?

A: My husband and I love to travel and have many more places here on Earth to check off our list. Next up is an Italian wine tour or New Year's in Barcelona!

Q: Describe yourself in three words.

A: Determined. Happy. Blessed.

Q: What is the best piece of advice you've heard?

A: "Just be yourself—it's the only way it can work." — Johnny Carson



NASA / PHOTO JSC2014E078906

Q: When did you first become interested in space, and why?

A: Growing up in the Houston area, I was surrounded by space news and events, but I didn't realize I was interested in working in the space industry until I completed an internship at NASA's Jet Propulsion Laboratory. The quality of people and projects across NASA, as an agency, is unmatched, and once I experienced firsthand the personal joy and fulfillment of working in spaceflight, I knew this is where I wanted to be.

Q: What is your favorite memory at JSC or of the space program?

A: The people. Working previously for the Space Shuttle Program and currently for the Multi-Purpose Crew Vehicle Program (MPCV), I have constantly been surrounded by quality people and managers, both inside and outside of the Flight Operations Directorate.

Q: What excites you most about NASA having a clear path to Mars?

A: The future of NASA. Once given a clear goal, I'm confident NASA, as an agency, can achieve anything. Mars may be a few years out, but it's exciting to be a part of the milestones that will get us there. As with previous manned flights, our national pride will soar with MPCV/Space Launch System.



JSC Feeds Families campaign a resounding success

WITH THE ENTICEMENT OF MANY gauntlets thrown—not to mention icy buckets of water—the Johnson Space Center family pulled together to support both the Galveston County Food Bank and Clear Lake Food Pantry during the JSC Feeds Families annual food drive.

The event capped off with the “Stuff a Truck” event at the Gilruth

Center on Aug. 27, and JSC Deputy Director Kirk Shireman challenged team members to stuff his truck on the way to the larger donation area. This led to an abundance of trucks, vehicles—and even a stray rover—to get in on the action, with a suitably rowdy parade leading the way.

By mid-day Aug. 27, the enthusiasm reached a fever pitch, only to be cooled slightly by senior management, including JSC Director Ellen Ochoa, getting drenched in the spirit of generosity.

The real victors of JSC’s competitive spirit, however, are the families in the surrounding community that will benefit from a surplus of food donations.



NASA/JAMES BLAIR

A forlorn-looking Shireman sits in the bed of his truck, silently challenging JSC team members to donate food to families in need.



NASA/DAVID DEHOYOS

JSC Director Ellen Ochoa, bottom center, and her fellow senior staff members JSC Deputy Director Kirk Shireman and JSC Associate Director (Management) Melanie Saunders, bottom left and bottom right, cringe as they await their icy fates.

Astronauts to launch again from American soil? You betcha

ON SEPT. 16, NASA confirmed the selection of Boeing and SpaceX as the first American companies who will launch our astronauts to the International Space Station from American soil. With this announcement, NASA has set the stage for its most ambitious and exciting chapter in the history of human spaceflight.

Now we are one step closer to launching our astronauts from U.S. soil on American spacecraft and ending the nation’s sole reliance on Russia by 2017. In addition, turning over low-Earth orbit transportation to private industry will allow NASA to focus on an even more ambitious mission—sending humans to Mars.



NASA /PHOTO

Roundup

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#ImOnBoard

Ashlé Harris



Orion engineers and NASA team members across the country are counting down the days until our nation's #Next Giant Leap. December



2014 will mark the beginning of Orion's #JourneytoMars. While interest in the test flight is innate for NASA's internal community, Orion has spent the past year working to engage an entirely unique sector.

Through social media, the Orion Program has recruited spectators and inspired followers from all

ages to get on board for Exploration Flight Test- 1. The public has been informed all about Orion through employee profiles, "tweet chats," Google+ hangouts and sharables.

Almost a year ago, the Orion Program started showcasing employees to tell the stories of the people working to create and manufacture America's next spacecraft. "I am building Orion" profiles allowed employees at NASA, Lockheed Martin and its subcontractors the opportunity to share what they do in regards to building Orion and what it means to them. The black-and-white photos showed Orion team members in their work environment and gave the public a sneak peek at a day in the life of an Orion engineer via Facebook.

Now, Orion is garnering support through a vinyl banner that became a



social media hashtag:

#ImOnBoard

Employees, kids, educators, engineers, and even celebrities, are following the mission by tweeting videos and



selfies with the Orion capsule while using the hashtag #ImOnBoard.

Not only that, but every week Orion is "spelling down" to launch with facts from A to Z about the spacecraft and its

mission. Followers can also learn more on #FactFridays.

These campaigns, along with Orion's supplier, museum and school visits, have demonstrated the public's growing support for Orion's next big steps.

Are you onboard? Continue to show your support by following the hashtags in this article on social media, and don't forget to post your #Imonboard selfie as we get closer to liftoff.

